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Maternal mortality in Switzerland 1995–2004

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Summary

Objectives: The analysis of maternal mortality is an important instrument for quality assurance in Obstetrics and should be accomplished periodically. This study analysed cases of maternal mortality between 1995 and 2004.

Methods: The Federal Statistical Office (BFS) provided all death certificates between 1995 and 2004 with an ICD-10 code in the obstetric field (indicated by the letter O). Additionally, all maternal mortality cases from the archive of the Institute of Legal Medicine (IRM), in Zurich, were investigated. All clinics with a maternal mortality case were asked to fill out a detailed anonymous questionnaire. The cases were classified by ICD-10 in direct, indirect and non-pregnancy-related cases.

Results: This study analysed 50 maternal mortality cases. The mean maternal age was 32 years and 50% had foreign nationality. Haemorrhage (including EUG) was the cause of death in 13 women, nine women died of thromboembolism and six women each of preeclampsia or primary infection. Other causes of death were cerebral bleeding, amniotic fluid embolism and others. We classified 32 cases as direct obstetric deaths, which resulted in a direct maternal mortality ratio of 4.15/100 000 live births. Direct maternal mortality associated with caesarean section was 0.06‰ (11/177 000 caesarean sections [average estimate]) and the underreporting was 20%.

Conclusions: Compared to the prior 10-year-period, the maternal mortality ratio decreased from 5.54 to 4.15. The mortality associated with caesarean section decreased 4.5 times. Women at risk are older mothers and those with a non-Swiss nationality, specifically non-Western nationalities. The most common cause of death in this period was haemorrhage, whereas in the previous period most women died of thromboembolism.

Key words: maternal mortality; haemorrhage; Switzerland

Introduction

Every year, about 529 000 women worldwide die due to pregnancy or delivery complications, with only 1% of maternal deaths occurring in developed countries [1].

Maternal deaths are not only a tragic event, but the analysis of maternal deaths is an important instrument for quality assurance in Obstetrics, because some cases could be avoidable [2–5]. It is essential to do periodical comparisons to acquire changes and trends. This is the only way to improve and develop obstetrical protocols to save maternal lives.

In 2003, Meili et al. published the study "Maternal mortality in Switzerland 1985–1994" [6]. Our study investigated the following 10-year-period between 1995 and 2004. In contrast to other countries, where this analysis is carried out annually [7], in Switzerland too little data is available to analyse periods shorter than 10 years.

The aims of this study were to

- analyse, in detail, the causes of obstetric death according to the data from the Swiss Federal Statistical Office between 1995 and 2004 and compare the results with the prior 10-year-period, and to demonstrate trends;
- estimate underreporting, on the basis of a cohort in the canton of Zurich;
- estimate the lethality of caesarean section compared to vaginal delivery;
- compare the direct maternal mortality in Switzerland with neighbouring European countries.

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Material and methods

For the years 1995 to 2004, 44 maternal death certificates were received from the Federal Statistical Office. Each clinic that was mentioned on a death certificate was asked to fill out a detailed anonymous questionnaire for each case. The questionnaire included personal anamnesis, family history, prior pregnancies and deliveries, operations, puerperium, fetal complications, as well as the results of the autopsy. In an accompanying letter, the clinics were asked to report additional maternal deaths that were not registered with the Federal Statistical Office between 1995 and 2004. One additional case was reported from a clinic.

The death certificates included a diagnosis of chapter 15 "pregnancy, delivery and labour, puerperium" of the ICD-10 classification, indicated as primary, immediate or concomitant cause of death [8]. Maternal death was defined according to the World Health Organization (WHO) classification (table 1) [7, 8]. With this classification the cases were comparable to the international literature [5].

To assess underreporting of maternal mortality in Switzerland, we looked specifically for additional reported obstetrical deaths in the archive of the Institute of Legal Medicine (IRM) at the University of Zurich, in addition to reports from the Federal Statistical Office.

Fisher's exact test was used to detect differences in maternal age as well as causes of death, such as haemorrhage and thromb-embolism after caesarean section compared to vaginal delivery. With chi-square tests for linear-by-linear association, the dependence of maternal mortality on maternal age was analysed. Statistical significance was assumed at an exact two-sided p-value of <0.05. The Ethical Committees of each participating canton approved the study.

Table 1

Classification of maternal deaths (ICD-10) [7, 8].

Classification	Definition	n
Direct obstetric deaths	Deaths resulting from obstetric complications of the pregnant state (pregnancy, labour and puerperium), from interventions, omissions, incorrect treatment or from a chain of events resulting from any of the above	32
Indirect obstetric deaths	Deaths resulting from previous existing disease, or disease that developed during pregnancy and which was not due to direct obstetric causes, but which was aggravated by the physiologic effects of pregnancy	9
Non-pregnancy-related maternal deaths	Deaths from unrelated causes which happened to occur in pregnancy or the puerperium	7
Late maternal deaths	Deaths occurring between 42 days and 1 year after abortion, miscarriage or delivery that are due to direct or indirect maternal causes	1
Unclear		1
Total		50

Results

Between 1995 and 2004, 44 obstetric deaths were reported to the Federal Statistical Office. One case occurred two years after delivery and therefore was excluded. In three cases we did not find any additional information except for the death certificate.

In the archive of the Institute for Legal Medicine, six additional cases were found and four of these six cases came from the canton of Zurich (one direct, one indirect and two non-pregnancy-related cases). Two cases came from other cantons. Together with the one case that was additionally reported from a clinic, 50 cases were analysed in total.

We classified 32 cases as direct obstetric deaths, 9 as indirect obstetric cases, 7 as non-pregnancy-related and one case as a late obstetric case. One case could not be classified due to scarce information (table 1).

Between 1995 and 2004, 771 206 live-born

Table 2

Maternal mortality by nationality and maternal age in Switzerland, 1995–2004.

	Maternal deaths (direct)	Live births	Maternal mortality/ 100 000 live births	Direct maternal mortality/ live births 100 000	Odds ratio (95% confidence interval)
Swiss nationality	25 (15)	565 896	4.4	2.7	1 (ref.)
Non-Swiss nationality	25 (17)	205 310	12.2	8.3	2.76 (1.58–4.8)
Maternal age (years)					
≤19	2 (0)	7775	25.7	0	21.7 (1.97–239.5)
20–24	1 (1)	84 414	1.2	1.2	1 (ref.)
25–29	10 (6)	234 412	4.3	2.6	3.6 (0.5–28.1)
30–34	23 (16)	291 640	7.9	5.5	6.7 (0.9–49.3)
≥35	14 (9)	152 965	9.2	5.9	7.7 (1.01–58.8)
Total	50 (32)	771 206	6.5	4.1	

children were registered in Switzerland [9]. The adjusted direct maternal mortality ratio was therefore 4.15/100 000 live births (32/771 206) within this 10-year-period. When the 10-year-period was divided in half, a decrease in maternal mortality ratio was found from 4.5/100 000 (18/403 151) in the first half to 3.8/100 000 (14/368 055) in the second half.

The mean maternal age at death was 32 years. A significant difference in mortality was found between different age groups (p = 0.012) and on average, the mortality increased by maternal age (p = 0.023) (table 2). The high mortality of women under 19 years could only be demonstrated in the total mortality, not in the direct mortality. Of all cases, 25 had a non-Swiss nationality of which 16 cases were of non-Western origin. Non-Swiss women had a three times higher mortality rate than Swiss women (table 2). The most common cause of death was haemorrhage (table 3). Seven women died of vaginal bleeding and three had non-vaginal bleeding. The non-vaginal bleeding came from the parauterine veins, the A. uterine or a retroperitoneal source (not specified). Three women died of an extra-uterine gravidity. Thromboembolism was the second most common cause of death, whereas preeclampsia and primary infections were equally the third most common causes of death. Of 50 cases, ten occurred during pregnancy, 16 cases had a spontaneous vaginal delivery; four cases had an operative vaginal delivery and 17 cases had a caesarean section. An autopsy was available in 64% of cases (32 out of 50 cases). On seven death certificates we did not find any further information.

To assess underreporting in the canton of Zurich, we compared the cases of the Federal Statistical Office with the cases of the archive of the Institute of Legal Medicine. In the canton of Zurich, 128 854 live births were registered between 1995 and 2004 [9]. The Federal Statistical Office registered, in this time period, four cases in the canton of Zurich resulting in a maternal mortality ratio of 3.10/100 000 live births. However, one additional direct obstetric death was found and therefore the direct maternal mortality ratio was at least 3.88/100 000 live births. This leads to an underreporting of 20%. If translated to the whole of Switzerland, we would expect at least six additional direct maternal deaths.

The mortality after caesarean section includes all maternal deaths that are timely correlated to a caesarean section and is independent of cause of death. In Switzerland, no frequency information regarding caesarean sections is available between 1995 and 2004. Therefore we had to assume an average rate of caesarean section of 23% (about 15% in 1995 and 29.2% in 2004) [10]. For 771 206 live births, we calculated 177 000 caesarean section as an estimated average in Switzerland for this time period. In the maternal mortality study, 11 out of 32 women (34.4%) had a caesarean section, but in one case the mode of delivery was unknown. Therefore, we found maternal mortality after caesarean section of 0.06‰.

The lethality after caesarean section, indicating a causal relationship between death and the caesarean section, is a subgroup of maternal mortality after caesarean section. The lethality demonstrates the direct additional risk of caesarean section for maternal death compared to vaginal delivery. We found four cases in the current study where a causal relationship between caesarean section and death was plausible. In two cases, death was related to haemorrhage and in the other two cases to embolism (one thromboembolism and one amniotic fluid embolism). In all other cases, the caesarean section was the consequence of a pregnancy related disease or disease aggravated during pregnancy: Preeclampsia/HELLP (n = 3), haemorrhagic shock (n = 2), amniotic fluid embolism (n = 1), placenta previa (n = 1), hypoxia (n = 2), fetal-pelvic disproportion (n = 1), infection (n = 2), obstructed labour (n = 1). We calculated lethality after caesarean section of 0.02‰ (4/177 000).

The frequency of haemorrhage and embolism after caesarean section was compared to vaginal deliveries and a significant difference was not found (haemorrhage p = 1.0, embolism p = 0.66) (table 4). Overall, the caesarean section did not lead to increased lethality compared to vaginal delivery in our study (OR 1.2, 95% CI 0.5–2.7).

Table 3

Causes of deaths and classification.

Cause of death	Total	Direct obstetric deaths	Indirect obstetric deaths	Non-pregnancy-related deaths	Late maternal deaths	Unclear	Average maternal age
	n	n	n	n	n	n	
Haemorrhage (including EUG)	13	12	1				33.8
Thromboembolism	9	6	2		1		29.4
Preeclampsia	6	6					30.7
Primary infection	6	2	2	2			29.5
Amniotic fluid embolism	5	5					38.4
Anesthesia complications	0						
Others	10	1	4	5			32.3
Unknown	1					1	

Table 4

Cause of death in relation to caesarean section (causal relationship possible); vaginal deliveries = 77% of 771 206 births.

Cause of death	Caesarean section	Vaginal delivery (direct cases)	Odds ratio	95% confidence interval	p value
Haemorrhage	2/177 000	6/594 000	1.1	0.23–5.5	1
Embolism	2/177 000	5/594 000	1.3	0.26–6.9	0.66

Discussion

The direct maternal mortality ratio in Switzerland was at least 4.15/100 000 live births between 1995 and 2004, and therefore this ratio had decreased by 25% compared to the prior 10-year-period (5.54/100 000). When the same time period was divided into two five-year-periods, the mortality ratio decreased by 15.6% from 4.5/100 000 (1995–1999) to 3.8/100 000 live births (2000–2004). In the prior 10-year-period, the decrease was 11.9% (1985–1989: 5.9/100 000 and 1990–1994: 5.2/100 000 live births) [6]. Several aspects have changed compared to the prior period: The mean maternal age at first delivery is increasing constantly and the older maternal age is a risk factor for maternal mortality. The classification of maternal deaths also changed since 1995: Before 1995, the ICD-8 classification was used in Switzerland and ICD-8 did not include specifications such as direct, indirect and not-pregnancy-related deaths. Following the last publication, an active management for data collection at the Federal Statistical Office was strongly suggested, including a systematic inquiry of all reported deaths of women of reproductive age. The proposed questions were: whether pregnancy had occurred and, if yes, whether the death was correlated. For all these reasons, we had expected an increase in maternal mortality in the time period between 1995 and 2004, following the installation of this control mechanism. However it seems that the mechanisms are currently not working properly and the training of physicians should also be improved.

Currently no data on severe maternal morbidity and near missed cases have been published in Switzerland. So far, no specific reporting system is installed to address this question, although in the light of a very low maternal mortality ratio the analysis of such data could improve maternal health.

To analyse the data, we classified the obstetric deaths by all available information according to the ICD-10 classification in direct, indirect and non-pregnancy-related deaths. We stratified amniotic fluid embolism, haemorrhage and preeclampsia as direct obstetric cases, but one retroperitoneal haemorrhage was classified as indirect death, because the bleeding was not due direct to an obstetric cause. Thromboembolisms were classified as direct causes, except for two cases: One case occurred during early pregnancy in a woman with adipositas per magna and in the second case the woman had a preexisting thrombophilia and presented too late for her first pregnancy check-up. One case of thromboembolism occurred eight weeks postpartum and was classified as late death. Two cases of infection were classified as direct death, two cases as indirect of which one case had a pneumococcal sepsis and two other cases were non-pregnancy-related. Three of five cerebral events were caused by bleeding, but in no case preexisting hypertension was described, therefore we classified both as indirect [5]. The two suicides were non-pregnancy-related, because in both cases depression was diagnosed before pregnancy.

The mortality risk increases with maternal age. Compared to the prior period, the mean maternal age increased from 30.7 years to 32 years. In Bavaria, Welsch et al. also found an increased mortality risk for older women [11]. It is not possible to discuss the mortality risk of very young women under 19 years, because this population is too small in Switzerland. Between 1985 and 1994, the proportion of non-Swiss women was 22.9%, whereas it increased in this study period to 50% [6]. The majority of foreign women were of non-Western origin (16 of 25). A reason for this increased maternal mortality rate could be a late first pregnancy check-up and, in general, less contact with medical staff, followed by late diagnosis and treatment of serious conditions [12]. In France, the number of deaths of foreign women is double that of native women [2]. In Bavaria, older reports found similar results, but a current study shows that this difference has dissolved [11]. This indicates that the obstetric counselling in Bavaria has improved, specifically for foreign women.

In the current study, women of older age and with a non-Swiss nationality are at risk.

Haemorrhage was the most common cause of death in the current study, followed by thromboembolism, preeclampsia and primary infection. In France and Italy, haemorrhage, particularly in puerperium, was identified as the most common cause of death [13–15]. In France, new guidelines for Good-Clinical-Practice have been initiated and they have identified the following risk factors for haemorrhage: maternal age, ethnicity, marital status, social status, education, irregular pregnancy check-ups, multiple pregnancy, preeclampsia, retroplacental haematoma, caesarean section and uterine scar [16]. For prevention they recommend Oxytocin after delivery of the infant's shoulder [17], as well as rapid diagnosis and treatment of bleeding [18]. Maternal deaths due to postpartum haemorrhage and anaesthetic complications are increasing. In the UK and Bavaria, the most common cause of direct obstetric deaths is still thromboembolism [7, 11]. Compared to other causes of death, the rate of thromboembolism is unchanged in Bavaria. Haemorrhage is the most common correctly documented cause of death, whereas thromboembolism is more difficult to diagnose and therefore is likely to be underestimated [13].

In Switzerland, the recommendations for the consequent thrombosis prophylaxis seem to work in practise [6]. Now an adapted management for haemorrhage should be installed in each delivery setting. The Swiss Society of Obstetrics and Gynaecology and the Swiss Society of Anaesthesiology and Reanimation have developed an algorithm for postpartum haemorrhage [19] including:

– written protocols for all necessary procedures in case of haemorrhage (interdisciplinary team: obstetricians, midwifes, anaesthesiologists);
– blood products available within 30 minutes and control of vein punctures;
– regular training of staff for emergency situations, for recognition of bleeding anomalies;
– knowledge of surgical procedures (clamps, B-Lynch suture, ligation of an uterine, hysterectomy) and when to use them [2].

In the current study, we found three cases of extra-uterine gravidity, whereas in the prior 10-year-period no case was reported. In two cases, gastrointestinal discomfort was reported while pregnancy was known. In both cases, the women were referred to the hospital too late. In the third case, no further information was available. In Bavaria, until the end of the year 2000, no further case of ectopic pregnancy was reported [11]. In contrast, in Italy 32 cases were registered between 1980 and 1996 [13].

Wildman et al. found differing distributions of causes of deaths depending on high or low maternal mortality rate in Europe [20]. Even though Switzerland has a comparably low maternal mortality rate, the distribution of causes of death is more similar to those countries with a higher mortality rate, which is characterized by haemorrhage and infections. This leads to the assumption that the emergency setting in Switzerland could be improved. The caesarean section rate seems to be high at 34.4%. Even though the majority of women died during puerperium (60%), the life threatening condition mostly started during pregnancy or delivery and only in rare cases after delivery. Due to the emergency caesarean sections, the number of deaths during puerperium seems increased [6]. Also in France and Finland, over three quarters of all deaths occurred during puerperium [15]. These numbers are comparable with Switzerland. The decreasing maternal mortality in Bavaria is mostly due to reduced ante- and intrapartum deaths, whereas the postpartum deaths remained stable at two thirds [11].

Underreporting of obstetric deaths is a well-known problem, also in developed countries [15, 21–22]. Assuming an underreporting value of 20%, we estimate the actual direct maternal mortality ratio at 4.93/100 000 live births in Switzerland. Underreporting of 20% (prior period 25%) in Switzerland is comparable to neighbouring countries: France 20–22% [15, 23], Bavaria 7% [11], Austria 38% [21], the Netherlands 26% [22], Finland 60% [15]. For Italy no data is available [13]. In countries where an active management of obstetric deaths (checkbox on death certificate) is missing, underreporting tends to be higher than in countries with active management [11].

Deneux-Tharaux et al. could show that underreporting is greater in regions with lower initial maternal mortality ratios and with the highest percent of indirect pregnancy-related deaths, leading to a smaller difference of revised pregnancy-related mortality ratios [15]. Underreporting is not predictive for a certain cause of death.

The mortality after caesarean section decreased from 0.28‰ to 0.06‰ and the lethality from 0.09‰ to 0.02‰ compared to the prior period [6]. Welsch et al. reported lethality after caesarean section in Bavaria of 0.03‰ between 1995 and 2006 [24]. In our study, two cases of haemorrhage and two cases of embolism (one amniotic fluid embolism and one thromboembolism) led to caesarean section-related deaths. In France, caesarean section had a 3.5 times higher risk than vaginal delivery, including high risks of anaesthetic complications, infections and thromboembolism [2]. Compared to vaginal delivery, the caesarean section did not lead to increased lethality in our study (OR 1.2, 95% CI 0.5–2.7). Similar results were presented for Bavaria by Welsch et al. [24].

In Europe, maternal mortality ratio estimates ranged from 3 to 13/100 000 at the end of the last century [25]. Recently published data for 2003–2004 show a range of maternal mortality ratio from 2/100 000 live births in Sweden, to 29.6/100 000 in Estonia [26]. In directly neighbouring countries, the maternal mortality ratio was 5.3 in Germany, 6.4 in Austria, 3.2 in Italy and 7.0 in France, comparable to 4.15/100 000 live births in Switzerland. Mortality ratios could differ by various registration procedures.

In Switzerland, the obstetric deaths decreased from 86 cases (thereof 58% direct cases) in the prior period to 50 cases (thereof 64% direct cases) between 1995 and 2004 indicating a decrease of 42% [6]. In the UK, the total maternal mortality ratio increased by 8% from 1997–1999 to 2000–2002 [7]. Compared to the UK (27% direct cases) [7], the number of direct cases in Switzerland is relatively high, but in France the proportion is even higher (79%) [2], whereas Finland has a similar rate to Switzerland (56%) [15]. In Germany (1983–1988) and the UK the direct obstetric deaths have been significantly reduced since the last comparison period, whereas the numbers of indirect obstetric deaths have been stable or increasing, most likely due to better diagnostic tools [11]. If the direct obstetric deaths comprise the majority of cases in a country, improvement of the quality of obstetrical care is possible. If indirect cases are the majority, the general health status of women in the reproductive age might be suboptimal and more should be invested into preconception care and pregnancy-related consultations [15].

In summary, we found:

– due to small numbers of maternal deaths in Switzerland, trends are difficult to prove statistically and can often only be described. It would be helpful to join an international group such as MOMS (European Concerted Action on Maternal Mortality and Severe

Morbidity) or PERISTAT to discuss the classification of difficult cases and to compare the results in larger cohorts;
- that a mandatory autopsy, ongoing official registration of maternal deaths and active management in cases of death of women in the reproductive age group are necessary;
- voluntary communication of maternal deaths by physicians to medical organisations would be beneficial to audit the cases independently in detail;
- training of physicians to fill out death certificates properly is necessary.

The results of investigations of maternal deaths should not only be used for retrospective analysis, but to highlight the topics that should be investigated in the future [11]. We should focus on preventable deaths, which comprise more than half of all direct cases with haemorrhage at the top of the list (75% could be avoidable) [2].

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